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INFLUENCE OF BIO-METHANATED DISTILLERY EFFLUENT ON SOIL BIOLOGICAL PROPERTIES AND SUGARCANE YIELD IN CALCIORTHENTS OF BIHAR

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ABSTRACT

A field experiment was established during 2011-12 in calcareous soil of Bihar to study the effect of bio-methanated distillery effluent on biological properties and yield of sugarcane crop. Seven treatment combinations of bio-methanated distillery effluent (BMDE) and graded dose of nutrients were tried in randomized block design. Results revealed that the integrated application of bio-methanated distillery effluent (150 m^3/ha BMDE) and 100% of NPK nutrient significantly improved the biological properties viz., bacteria population (37.40%), fungi population (69.23%), azotobactor population (84.31%), Phosphatase activity (45.00 µg nitrophenol/g soil/h), Dehydrogenase activity (10.00 µg TPF/g soil/h) and urease activity (18.00 µg NH4-N/g soil/h) as compared to control. The improvement in soil biological properties in treatment consisting combinations of BMDE and 100% NPK were produced satisfactory cane yield (129.4%) over control. The positive polynomial correlations was observed between soil organic carbon and urease activities which is clearly demonstrate the important role of organic carbon on improving in biological properties of soil.

KEYWORDS: Sugarcane, BMDE, Microbial Population, Enzymetic Activity & Yield

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Original Article

INTRODUCTION

Sugar factories generate many by-products *viz*., bagasse, molasses, press mud and waste materials. Molasses is used in distillery industry as a raw material for the production of alcohol and distilleries discharge waste water called as spent wash. For production of each litre of alcohol, 12-15 litre of effluent is produced. Approximately 40 billion litres of waste water is generated per annum from 319 distilleries in the country (Kanimozhi and Vasudevan, 2010). It is rich in nutrients and organic components with high biological oxygen demand (BOD) and chemical oxygen demand (COD) i.e., 40000-50000 mg/l and 90000 -100000 mg/l, respectively (Pathak *et al*., 1998) due to that it is not directly use in agricultural fields. There was a remarkable reduction in BOD, COD and salinity after bio-methanization process using methane gas and utilizing methogenic bacteria. Therefore, upon field application, it increases the soil organic matter content, as well as nutrient and mineral contents. This condition may be favourable for number of microbes and enzymes in soils. The manurial value of the effluents can profitably be used as supplement to fertilizer and organic matter.

The bacterial population was changed due to different levels of treated distillery effluent (TDE) and fertilizers. However, the graded doses of TDE and NPK fertilizers had recorded the highest bacterial population among the rest of the treatments. The application of graded doses of TDE increased the fungal population. The fungal population was found to be enhanced at high levels of treated distillery effluent (TDE) application (Previnaan and Saravanan, 2013). Dehydrogenase is considered as important enzymes for oxidative process in the

soil. The enzyme activity is important for nutrient cycling and transformation. Application of TDE enhanced the activities of enzymes in the post harvest soils especially at higher levels. Addition of organic matter through TDE may leads to improved organic carbon. Increased enzyme activity over periods might be due to increased microbial activity which would have enhanced the organic matter degradation and mineralization (Saliha *et al*., 2005). Application of NPK fertilizer also showed significant effect on dehydrogenase activities. Similar increase in soil phosphatase activity with the application of biomethanated distillery effluent was also reported by Kalaiselvi and Mahimairaja (2009). The several fold increase in the activities of urease and phosphatase due to spentwash application might be ascribed to the addition of organic matter and subsequent increase in the microbial biomass (Bhakiyathu *et al.,* 2005). Indiscriminate disposal of the effluent in water and on land leads to soil pollution and alter the nutrient and biological conditions of the soil where they are disposed off. Therefore, current study aimed at evaluating the effect of different combinations of BMDE and inorganic fertilizer on soil biological properties of soil and crop yield in one year of field experiment.

MATERIALS AND METHODS

A one year of field experiment was conducted during 2013-2014 at the experimental farm of Department of Soil Science, Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar (Formerly Rajendra Agricultural University, Pusa). The soil belongs to order Entisol, suborder Fluvents and great group Ustifluvent, sandy loam in texture. Salient physical and chemical properties of the experimental soil of 0-30 cm depth were bulk density 1.40 g/cm^3, pore space 47.0%, infiltration rate 0.27 cm/hr, pH 8.15, organic carbon 4.2 g/kg, free $CaCO_3$ 34.0%, available N 230 kg/ha, P_2O_5 20 kg/ha and K_2O 133 kg/ha, SO_4^{2-}S 10.0 mg/kg, Fe 9.58 mg/kg, Mn 3.10 mg/kg, Cu 1.25 mg/kg and Zn 0.65 mg/kg, bacteria 20×10^5, Fungi 10×10^4 and Azotobactor 12×10^3 CFU/g. The average maximum and minimum temperature during experimentation (February, 2013-January, 2014) were 35.4 ^oC and 7.3 ^oC, respectively; average annual rainfall was 79.8 mm, most of which was received between May to October. The experiment was laid out in randomized block design, replicated four times within a block and involved seven treatments *viz*., T_1: 100% NPK; T_2: 150 m^3/ha (BMDE); T_3 : T_2+100% NPK; T_4 : T_2+75% NPK; T_5: T_2+50% NPK; T_6: T_2+25% NPK; and T_7: Control. The BO 141 (mid-late) cultivar of sugarcane crop was shown in well prepared field on dated 24th February 2013 in plot size of 9.41 m × 5.21 m. Recommended doses N, P_2O_5 and K_2O is 150 kg/ha, 85 kg/ha and 60 kg/ha, respectively, and were applied as per the treatments of the experiment in the form of calcium ammonium nitrate, single super-phosphate and muriate of potash. Entire dose of N, P and K fertilizers was applied at the time of field preparation. The applied BMDE contain pH 7.31, organic carbon 140.9 g/kg, available N 0.40%, available P 0.082%, available K 9.25%, available S 0.82%, available Fe 7.0 mg/l, available Zn 6.5 mg/l, and available Cu 4.6 mg/l available Mn 4.1 mg/l, BOD 5500 & COD 35500 and TDS 4000 mg/l). Four representative soil samples from 0-30 cm depth were collected before crop sowing and after crop harvest for analysis of biological properties following standard procedures. Collected composite soil samples were dried under shade, powdered with wooden mallet and sieved through 2 mm sieve and the population of bacteria; fungi and azotobactor colonies were assessed by plating dilution technique by adopting the analytical methods as suggested by Waksman and Fred (1922). Dehydrogenase activity was determined by triphenly farmazane method (Casida *et al*., 1965), phosphatase activity was determined by adopting p-nitrophenyl phosphate method as described by Tabatabai and Bremner (1969), and Urease activity was determined by NH_4-N Distillation method as given by Bremner and Keeney, 1966. Cane yield data were recorded at the age of 12 months from the plots and were converted to yield t/ha. Statistical analysis of data was performed using the SPSS statistical package and the treatment means were compared using least significant difference at 5 per cent probability.

RESULTS AND DISCUSSIONS

Soil Biological Properties

Microbial Population

The bacteria population was markedly affected due to different combination of BMDE and NPK nutrients after harvest of sugarcane (Table 1). It ranged from 28.75 to 39.50 × 10^5 CFU/g of post harvest soil. Among the treatments, T_3 : T_2 (150 m^3/ha BMDE)+100% NPK significantly recorded the highest microbial population *viz*., bacteria (39.50 × 10^5 CFU/g), fungi (22.0 × 10^5 CFU/g) and azotobacter (23.50 × 10^5 CFU/g) which was statistically similar to T_4 : T_2+75% NPK. However, the lowest microbial population was recorded with control (T_7). The increase in microbial population might be due to the fact that bio-methanated distillery effluent is easily bio-degradable liquid organic matter containg high level of nutrient and polysaccharide (42.70%) which serve as a source of carbon and sulphate for microbial proliferation. These results are in close conformity with the findings of Maheswari, (2011), Selvamurugan *et al*. (2011), and Previna and Saravanan (2013).

Enzymatic Activity

The enzymatic activity is important for nutrient cycling and transformation which is important for crop. Significant variation in soil enzymatic activity *viz.*, phosphates activity, Dehydrogenase activity and urease activity was recorded from 5 to 45 µg nitrophenol/g soil/h, 2-10 µg TPF/g soil/h and 4-18 µg NH_4-N/g soil/h due to different treatments (Table 1). The highest phosphatase activity (45.00 µg nitrophenol g^{-1} soil h^{-1}) was found in treatment T_3, receiving 150 m^3/ha BMDE along with 100% NPK while lowest in treatment T_7 i.e. control. The highest phosphatase obtained under T_3 was at par with T_4 (43 µg nitrophenol/g soil/h), receiving 150 m^3/ha BMDE along with 75% NPK and significantly superior to rest of the treatments. Increased enzyme activity might be due to increased microbial activity which would have enhanced the organic matter degradation and mineralization. The positive polynomial correlations was observed between soil organic carbon and urease activities ($y = 0.0036x2 + 0.1013x + 2.9811$; $R^2 = 0.9693$) which is clearly demonstrate the important role of organic carbon on improving in biological properties of soil. Patil *et al*. (1982) reported that the spentwash contains about 42.7% polysaccharides which have served as a source of carbon substrate for enzyme activities. These results are in conformity with the findings of Selvamurugan *et al.* (2011), Tripathi *et al*. (2011), and Previna and Saravanan, (2013).

Cane Yield

Bio-methanated distillery effluent and different dose of NPK nutrients were produced significant effects on cane yield of sugarcane (Figure 1). The highest cane yield (92.0 t/ha) was obtained in treatment, T_3 which was statistically at par (86.9 t/ha) with treatment, T_4. Whereas, treatments, T_2 and T_1 were produces similar effect on cane yield. Overall, the percent increment of cane yield under treatment T_3 was 129.4% over control. The results are in conformity with the findings of Tamilselvan and Jayabal (1993), and Sekar (2003) who reported that the cane yield observed the positive impact of availability of individual plant nutrients from BMDE and balanced supplement of NPK through inorganic fertilizers might have induced cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency and regulation of water intake into cells, resulting in the enhancement of cane yield.

CONCLUSIONS

It is concluded that the conjoint application of bio-methanated distillery effluents and graded dose of NPK

nutrients could be very well used as a source of plant nutrients for sustaining the soil biological properties and yield of sugarcane.

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APPENDICES

Table 1: Effect of Bio-Methanated Distillery Effluent on Microbial Population and Soil Enzymatic Activity in Post Harvest Soil (0-30 Cm Depth)

Treatments	Soil Microbial Population			Soil Enzymatic Activity		
	Bacteria (1×10^5 CFU/g)	Fungi (1×10^4 CFU/g)	Azotobactor (1×10^3 CFU/g)	Phosphatase (µg nitrophenol/g soil/h)	Dehydrogenase (µg TPF/g soil/h)	Urease (µg NH_4-N/g soil/h)
T_1: 100% NPK	29.75	13.50	15.00	15.00	3.00	7.00
T_2 : 150m^3/ha (BMDE)	31.00	13.75	16.25	26.00	6.00	9.00
T_3 : T_2+100% NPK	39.50	22.00	23.50	45.00	10.00	18.00
T_4 : T_2+75% NPK	37.25	20.72	21.22	43.00	9.00	16.00
T_5: T_2+50% NPK	35.50	16.75	19.25	35.00	7.00	13.00
T_6: T_2+25% NPK	32.00	14.25	16.50	30.00	5.00	11.00
T_7: Control	28.75	13.00	12.75	5.00	2.00	4.00
SEm ±	1.19	0.44	0.79	0.98	0.45	0.57
CD (P=0.05)	3.45	1.28	2.28	2.90	1.34	1.66
CV (%)	7.11	5.53	8.85	7.08	6.85	8.22

*CFU-colony forming unit

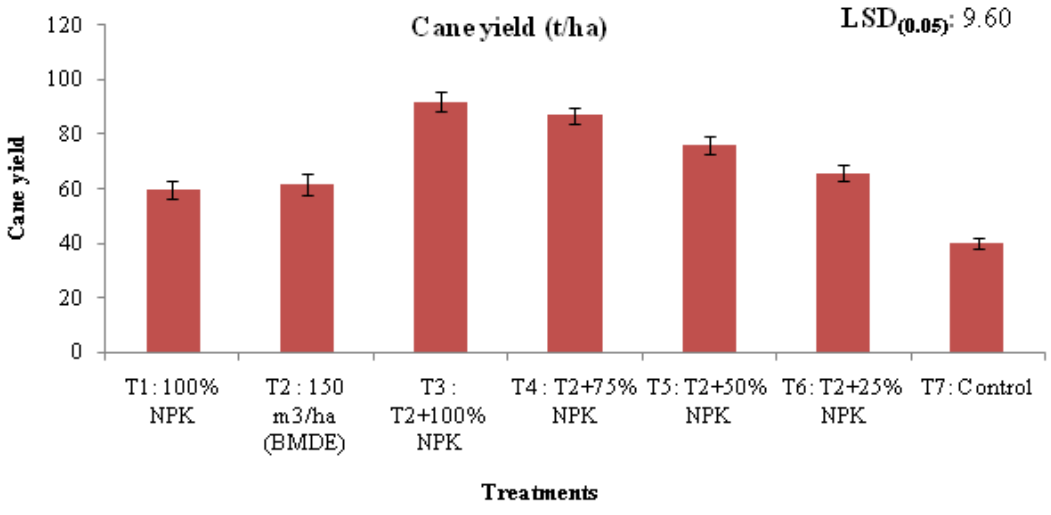

Figure 1: Effect of Bio-Methanated Distillery Effluent on Cane Yield of Sugarcane. Vertical Bars Indicate ± S.E. of Mean of the Observed Values

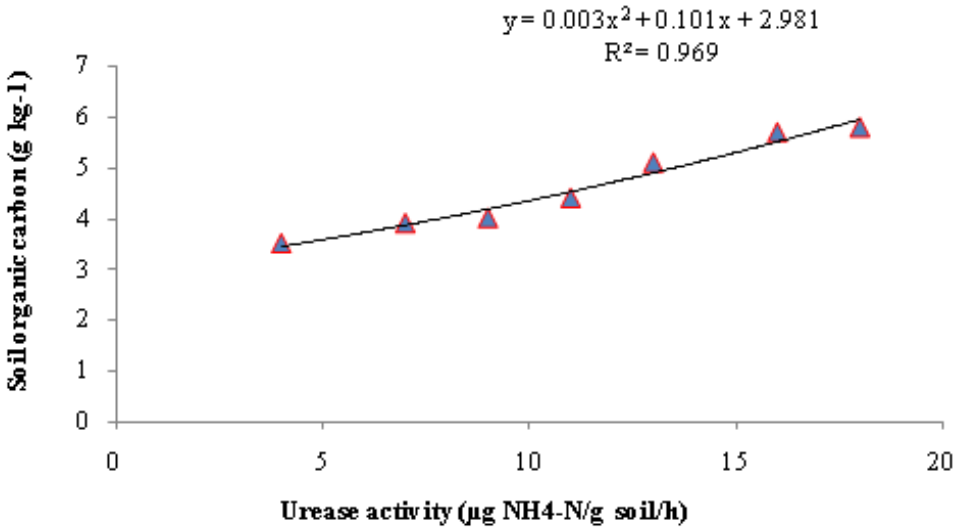

Figure 2: Relationship between Soil Organic Carbon and Urease Activity Under Different Treatments in Sugarcane Crop